

Yoshio SHIMURA*: Studies on the spores of *Athyrium multifidum* and esteemed hybrid-origin of the species

志村 義雄*: オオサトメシダの胞子の研究による雑種起源の推定

As regards the shape of spores of *Athyrium multifidum*, the previous report was made by T. Kawasaki²⁾ and as regards the esteemed hybrid-origin of this species, another report was made by S. Kurata.⁴⁾ In order to reinvestigate the shape and the surface of the spores which are dealt with in Kawasaki's paper and in order to conjecture the origin of this species from the morphology and development of the spores, I have carried out the observations and experiments for the last few years. I am grateful to Mr. Kurita at Chiba University for his help and advice. I am also thankful to Mr. K. Torii at Sinsiro City, for his kindness in providing me with the material.

Materials and methods As a control of the study, I used *Athyrium deltoideifrons* of which the shape, colour and the formation of the spores are already known. Because, it is generally said that *A. multifidum* have some affinity with *A. deltoideifrons*.

A. multifidum under my study was collected from the following districts: (Locality, A) Inokasira, Fujinomiya City, Suruga Prov. (June 25, 1960 and June 21, '63); (Loc., B) Kamihirase Tamagawa-mura, Suruga Prov. (Aug. 31, 1957, June 28, '60, July 4, '62 and July 12, '63); and (Loc., C) Mt. Dando, Mikawa Prov. (Sept. 19, 1960).

The fern of Loc. A has been transplanted to Ōiwa, Shizuoka City since 1960, the ferns of Loc. B have been transplanted to the same place since 1957 and the fern of Loc. C has been transplanted to Nisisinmati, Sinsiro City, Mikawa Prov. by K. Torii since 1958. As to the ferns that were transplanted Shizuoka City, the mature time of their sporangia was observed from June to November in each year.

The spores of *A. deltoideifrons* were collected from Loc.: A, B, C and also from Kurata, Fujieda City, Suruga Prov..

These spores belonging two species were collected by the following method. Some pinnae with mature sporangia were placed on white sheet of paper of good quality. After 24 hours, I removed the pinnae leaving spores on the paper.

* Biological Institute, Faculty of Education, Shizuoka University. 静岡大学教育学部生物学教室.

They were sorted using the faint breeze. Germinating medium for these spores was Meyer's solution containing 8 % of agar. In every experiment, four Petri dishes (9 cm in diameter) were prepared. The spores were sowed in the dishes which contains 20 cc of the medium, within a week after their collection. These dishes were placed on a table in the laboratory under the diffused light. The temperature in the laboratory was recorded by the thermograph.

The rate of germinated spores was as follows: After two weeks or one month after sowing, 500 spores per one dish were counted by the method of unintentional action. Thus, the average germinating rates of these spores were obtained out of the total germinating rates that are found from the four dishes. These experiments were carried out during the period from June to August. Some cytological observations of the spores of *A. multifidum* were made through the assistance of Mr. S. Kurita.

Results (1) The spores of *A. multifidum*

The mature time of the sporangia begins about in the middle of June. The fertile fronds produce a large number of sorus, but the sporangia which contain the spores are very scarce. Therefore, the collection of the spores is always very difficult. Some of sporangia contain 16 spore mother cells (Photo. 1) and both in a anaphase and a telophase of their meiosis, some univalent chromosomes and some bivalent chromosomes were observed (Photo. 2). These sixteen spore mother cells in a sporangium seem to give rise to 16 spores (Photos. 3, 4). Some of the spores are nearly spherically reniform in shape and others are irregular, they are various in size (Photos. 5, 6, 7). Some of them range from 60μ to 70μ in diameter and their surface is covered with many little warts (Photo. 6). The exospore seems to be rather hard. The colour of the most spores is deep orange. The germinating rate of the spores ranges only

Tab. 1. Germinating rates of spores of *A. multifidum*

Date of collection	Date of sowing	Date of count	Germinating rate (%)	Temperature (C°)	Locality of collection
June 23, '63	June 25, '63	July 24, '63	6	24°-31°	C cultivated land
June 22, '63	June 24, '63	July 24, '63	1	24°-31°	A cultivated land
July 12, '63	July 17, '63	Aug. 17, '63	8	24°-32°	B natural habitat

from 1 % to 8 % (Tab. 1). In this experiment, some of large and spherical reniform spores germinated. Several of them developed into prothallia.

(2) The spores of *A. deltoidofrons*

The mature time of the sporangia begins early in June. Kurita³⁾ reports that the formation of the spore is normal and Kawasaki²⁾ also reports that the spores are reniform-ellipsoid in shape, their surface is covered with little warts and their colour is orange. The fertile fronds from many mature sporangia and the collection of the spore is very easy. The spores are generally 57μ in long diameter and are also 35μ in short diameter. The germinating rate of the spore is always more than 91 % according to the same experimental method (Tab. 2).

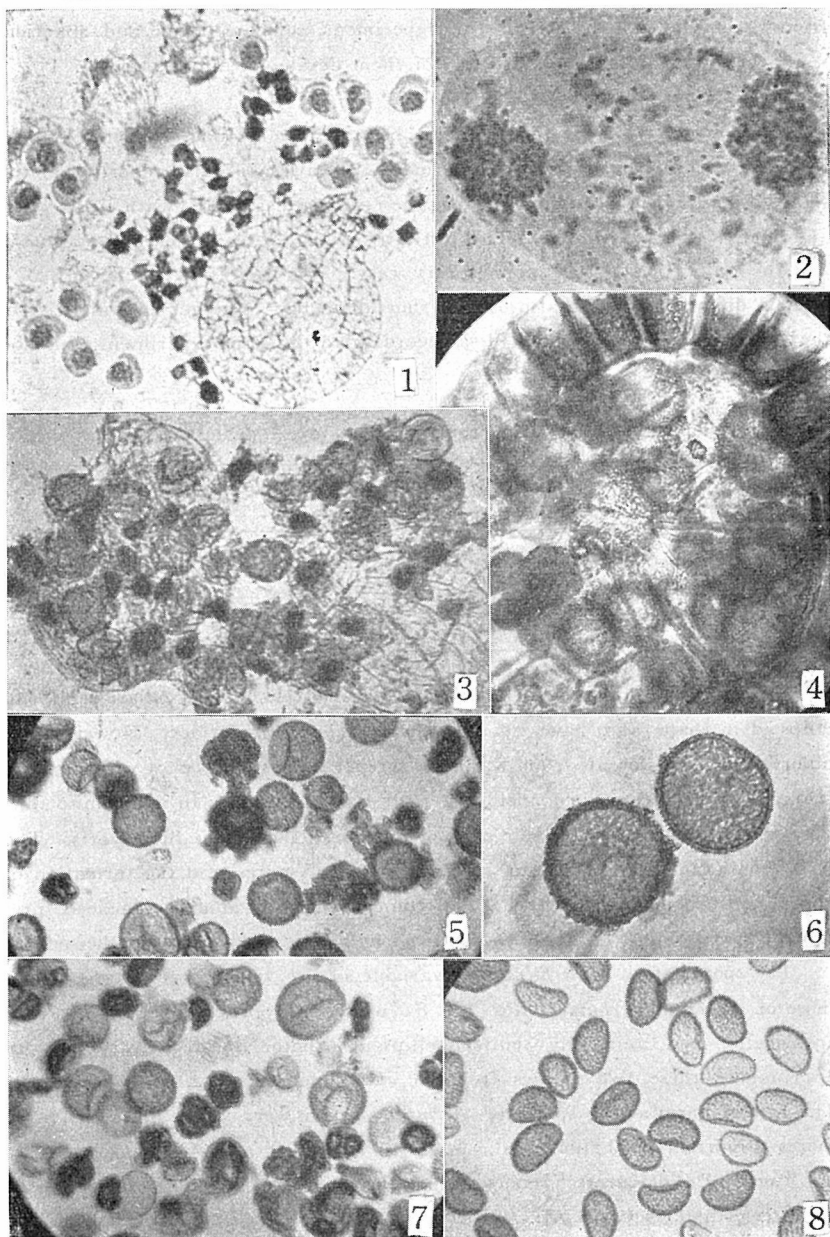
Tab. 2. Germinating rates of spores of *A. deltoidofrons*

Date of collection	Date of sowing	Date of count	Germinating rate (%)	Temperature (C°)	Locality
July 12, '63	July 17, '63	Aug. 17, '63	93	24°-32°	B (natural habitat)
July 10, '62	July 28, '62	July 28, '62	91	24°-31°	A (natural habitat)

Discussion According to Kawasaki²⁾ spores of *A. multifidum* are reniform-ellipsoid in shape and have no protuberance on their surface. However, my observation is different from Kawasaki's report. Actually, most of the spores is almost spherical-reniform including some irregular ones. In addition to this, they are various in size. Their surface is covered with many little warts. The irregularity and variability in size and shape of spores and the formation of aborted sporangia seem to have some connection with abnormal meiosis, presumably pseudomitosis. These specialities may be said to characterize the species.

The spores of *A. multifidum* are variable in size, but in general larger than those of *A. deltoidofrons* (Photos. 1, 3, 8), while the spores of *A. deltoidofrons* are smaller and uniformly reniform-ellipsoid (Photo. 8). It is very easy to discriminate these two species from the morphological stand point of spores. The rate of germinating spores of *A. multifidum* is very small, but the fertile spores to normal prothallia.

Tagawa¹⁾ and Kurata⁴⁾ reported that the fronds of *A. multifidum* seem to be intermediate between *A. deltoidofrons* and *A. vidalii*. Thus, Kurata has



pointed out that *A. multifidum* was derived from the hybrid of these two species. The theory of hybrid-origin of *A. multifidum* is also explained from my study on spores morphology. That is: (1) Some of the spores are nearly spherical-reniform and others are irregular. (2) They are various in size and some of them are remarkably large. (3) A large number of sporangia are immature with a few exceptions. (4) Sixteen spore mother cells are contained in some sporangia and they seem to give rise to 16 spores. (5) The meiosis is abnormal. (6) The germinating rate of the spore is very small. The most spores are sterile. (7) The spores are abnormal.

Reference

- 1) Tagawa, M. (1959): Col. III. Jap. Pterid. 121, 184. 2) Kawasaki, T. (1960): Studies on the sexual generation of ferns (15). Journ. Jap. Bot. **35**: 17-15. 3) Kurita, S. (1960): Chromosome numbers of some japanese ferns. Journ. Jap. Bot. **35**: 13-16. 4) Kurata, S. (1961): Notes on japanese ferns (21). Journal of Geobot. **9**: 97, 100.

Explanation of photos

1. Sixteen spore mother cells which are pulled out of a sporangium of *A. multifidum*. (Loc. A, cultivated, photographed by Kurita.) 2. Anaphase of the first meiosis of the same species. Univalent chromosomes left on the equatorial plate. (Loc. A, cultivated, photographed by Kurita.) 3. Sixteenspores which are pulled out of a sporangium of the same species, another sporangium is sterile. (Loc. A, cultivated, photographed by Kurita.) 4. Shown spores in a sporangium of *A. multifidum*. $\times 400$. Notice the shape, the size and number of the spore. (Loc. A, cultivated.) 5. Spores of *A. multifidum*. $\times 300$. Spherical reniform and irregular in shape, various in size. (Loc. B, natural habitat.) 6. Two large spores of the same species. $\times 600$. (Loc. B, natural habitat.) 7. Spores of *A. multifidum*. $\times 300$. (Loc. C, cultivated.) 8. Spores of *A. deltoidofrons*. $\times 300$. (Loc. B, natural habitat.)

摘 要

川崎²⁾はオオサトメシダの胞子の形態について発表し、また倉田³⁾は、オオサトメシダの葉の形態から、このシダの雑種起源を推定した。筆者は自生地および栽培地におけ

るオオサトメシダについて、特にその胞子の形態を再検討し、この形成状態、発芽能力および胞子嚢などを観察し、これらの結果から、倉田と同じ結論に達した。

オオサトメシダ胞子の主な形状は、殆んど球状に近い腎状体である。しかし不定形の胞子も多くみられた。その表面は多数のイボ状物がある。この胞子の大きさは大小不揃であった。川崎の発表したオオサトメシダの胞子の形状は、腎状橢円体、その表面は無突起であるので、この両点において、筆者の観察結果は異なった。

このシダの大多数の胞子嚢は不稔性である。稀には成熟するものがあり、この胞子嚢内には、16 個の胞子母細胞が観察された。この胞子母細胞の減数分裂において、赤道板に 1 価染色体が残されているのがみられた。胞子嚢内には、16 個の胞子が観察された。これは特異な胞子形成と思われる。このシダの多くの胞子嚢は不稔性であり、稔性胞子の形成は少量であるから、胞子の採集は困難であった。この胞子の発芽能力は非常に劣る（発芽率は 1%—8%）。多数の不稔性胞子嚢があり、胞子の主な形は球形腎状体、その大きさは不定などは、オオサトメシダの特性の一部にあげられよう。またそれらの点では平常であるサトメシダとの区別点にも数えられる。

以上列挙した胞子の形状、大きさ、その形成状態、発芽能力の劣ること、多数の不稔性胞子嚢の存在などの諸観点から考察して、オオサトメシダの起源は雑種であるとの疑がある。

□Riley, H.P. **Families of flowering plants of Southern Africa.** pp. 269, pls. 144. University of Kentucky Press (1963). 著者はケンタッキー大学の細胞遺伝学の教授で、染色体の方面から南アフリカの高等植物に関心を持ち、1955 年にフルブライト交換教授として、南阿連邦に滞在した時の資料を主に整頓したものである。範囲は南阿連邦に限らず、アンゴラとモザンビークとを結ぶ以南の植物を一応網羅し、ハッチンソンの分類系に準じて排列、各科の特徴、科中の所産の各属を列挙し、可成り詳しい分布を述べ、なお染色体数と利用面をも附記する。純粹の分類書ではなく、挿入のカラー写真と相俟ってフロラの大綱を知るにはよい。写真はほとんど草本なので、下記の Palmer 及び Pitman 両氏の「南阿樹木誌」を併用されると一層よい。\$14.00 (前川文夫)

□Palmer, E. & Norah Pitman: **Trees of South Africa**, pp. 352 pls. color. 31. photo pls. 148. A. A. Balkema, Amsterdam & Cape Town (1961). 少し古いが面白い本なので紹介する。南阿連邦の主要樹木を扱ったもので専門書ではない。第一部 111 頁で、歴史的展望、保護、分布、南部の Knysna 地方の樹木の検索表、特徴を抄出した種類毎の表、名のいきさつ、雨を呼ぶ木、栽培、役に立つ木などが述べてある。第二部に入るとハッチンソンの“A Botanist in South Africa”に準じて 59 科、174 種について、どちらかという民俗植物学的に楽しい記述がされている。写真は主に樹形を写し、多数のしゃれた挿画は細部を描く。土語も多く載せ、終りに 65 ケ所の自然保護林の地図もよい参考となる。(前川文夫)